MOBILE TERMINAL HANDOVER FROM A SECOND GENERATION NETWORK TO A THIRD GENERATION IP-BASED NETWORK

PRIORITY STATEMENT UNDER 35 U.S.C. § 119(e) & 37 C.F.R. § 1.78

This nonprovisional application claims priority based upon the prior U.S. provisional patent application entitled, "System and Method for Handing Over a Circuit-Switched Call to a Mobile Station Operating in a Packet-Switched Network", application number 60/162,532, filed October 29, 1999, in the names of Suhail Hasan, David Sugitharaj, Hung Tran, and Ibrahim Ozkan.

BACKGROUND OF THE INVENTION

Technical Field of the Invention

This invention relates to telecommunication systems and, more particularly, to a method of handing over a mobile terminal from a second generation (2G) circuit-switched network to a third generation (3G) Internet Protocol (IP)-based network.

Description of Related Art

The third generation IP group (3G.IP) is a focus group that develops technical solutions for IP-based networks that will be introduced into the Third Generation Partnership Program (3G.PP) for standardization. Mobile terminals (MTs) access IP-based networks through a Radio Access Network (RAN), and the primary RANs in 3G.PP are the Enhanced Date Rates for General Packet Radio Service (EDGE) or the Universal Mobile Telecommunication System (UMTS), while the call control protocol may be either H.323 or the Session Initiation Protocol (SIP) to support real-time multimedia traffic.

3G.PP requires 3G networks to support new and existing services in such a way as to provide interworking of the services with other 3G networks and also with legacy second generation (2G) networks. These services may include, for example, speech, data, multimedia, Short Message Service (SMS), supplementary services, Virtual Home Environment (VHE), and new IP-based services such as email, etc. As such, 3G.PP requires the provisioning of handover of ongoing voice-only calls from

a 2G system to a 3G system.

There are no known solutions for dealing with 2G-to-3G handovers. An existing contribution to the 3G.PP standardization group has proposed a solution for the reverse, that is, the 3G-to-2G handover. However, handover from a 2G system to a 3G system is inherently more complicated than a 3G-to-2G handover. Setting up of the handover is complex, requiring a change of protocol stacks in a dual-stack mobile terminal, a change of radio frequency and time slot, and much more.

It is desirable for MSs to be able to roam freely, back and forth between older 2G networks and new 3G networks. In particular, it is desirable to be able to handover an MS from a 2G network to a 3G network so that the operator can offer additional services to the MS. Therefore, a method of handing over a mobile terminal from a 2G circuit-switched network to a 3G IP-based network is needed. The present invention provides such a method. The invention is applicable to Class B MSs that can utilize either the packet-switched 3G network or the circuit-switched 2G network at any given time, but not simultaneously.

SUMMARY OF THE INVENTION

In one aspect, the present invention is a method of handing over a mobile terminal from a first cell to a second cell of the type in which the first cell is in a first type of network, and the second cell is in a second type of network. The improvement provided by the present invention is that the handover is triggered not just by the availability of service by the second type of network, or by a stronger signal strength from the second type of network, but also by a request for a service that requires a capability of the second type of network. In the preferred embodiment, the first type of network is a second generation (2G) circuit-switched radio telecommunications network, and the second type of network is a third generation (3G) Internet Protocol (IP)-based radio telecommunications network.

In another aspect, the present invention is a method of handing over a mobile terminal from a 2G circuit-switched radio telecommunications network to a 3G IP-based radio telecommunications network. The method includes the steps of establishing a call from the mobile terminal in the 2G network, determining that the

mobile terminal is operating in an area of 3G network coverage, preregistering the mobile terminal with the 3G network, determining that the mobile terminal is requesting a service that requires 3G network coverage, and handing over the mobile terminal from the 2G network to the 3G network. Preregistration of the mobile terminal may include acquiring an IP address for the mobile terminal, acquiring a Gatekeeper having a Call State Control Function (CSCF), preregistering the mobile terminal with the CSCF, selecting a Gateway General Packet Radio Service (GPRS) Service Node (GGSN) as an Anchor GGSN, and selecting a Serving GPRS Service Node (SGSN) serving the target cell in the 3G network.

In yet another aspect, the present invention is a method of handing over a mobile terminal from a 2G Anchor Mobile Switching Center (MSC) in a 2G circuit-switched radio telecommunications network to a SGSN in a 3G IP-based radio telecommunications network. The method includes the steps of detecting by the mobile terminal that coverage is available from a target cell in the 3G network, preregistering the mobile terminal with the 3G network, determining whether the mobile terminal is requesting a service that requires 3G network coverage, retaining the mobile terminal in the 2G network if the mobile terminal is not requesting a service that requires 3G network coverage, and handing over the mobile terminal from the 2G network to the 3G network if the mobile terminal is requesting a service that requires 3G network coverage.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and its numerous objects and advantages will become more apparent to those skilled in the art by reference to the following drawings, in conjunction with the accompanying specification, in which:

FIG. 1 is an illustrative drawing of a broad area of 2G coverage in which smaller pockets of 3G coverage have been deployed;

FIG. 2 is an illustrative drawing of a 2G protocol stack and a 3G protocol stack in a dual-stack mobile terminal suitable for use with the method of the present invention; and

FIGS. 3A-3C are a message flow diagram illustrating the messages, message content, and functions performed by network elements during a 2G-to-3G handover in accordance with the teachings of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

The present invention is a method of handing over a mobile terminal from a second generation (2G) circuit-switched network to a third generation (3G) all IP-based network. Handover from a 2G system to a 3G system is inherently more complicated than a 3G-to-2G handover. MTs operating in 2G circuit-switched systems utilize a circuit-switched protocol layer and deal only with a circuit-switched architecture. To begin a call in a 2G environment and then be handed over to a 3G network requires not only a change of radio frequency and time slot, but also changing protocol stacks in a dual-stack MT, acquiring an IP address for the MT, acquiring a Gatekeeper having a Call State Control Function (CSCF), and registering the MT with that CSCF. Additionally, a Gateway GPRS Service Node (GGSN) must be chosen as an anchor GGSN, a Serving GPRS Service Node (SGSN) serving the target 3G cell must be identified, and Packet Data Protocol (PDP) and Mobility Management (MM) contexts must be set up in the core network. Of course, all of the above must be performed without dropping the call. There is also the added issue of when to actually perform the handover. Mere entry into an area of 3G coverage may not be sufficient grounds to implement a costly handover. The present invention implements a 2G-to-3G handover in a manageable and efficient manner.

In the method of the present invention, the critical factor triggering a 2G-to-3G handover is whether the user requires 3G services. If the user is just using speech services during and after a proposed handover to a 3G system, the benefit of setting up a PDP Context and CSCF registration may not be worth the effort, both to the caller and to the carrier. The decision to handover from 2G-to-3G is based primarily on the type of services required, rather than merely the availability of 3G coverage. If the PLMN operator can provide value added services such as concurrent ongoing speech along with email access and Wireless Application Protocol (WAP) service, the 2G-to-3G handover becomes a cost-effective procedure.

This invention solves complex issues involved in moving from a 2G call-control system to a 3G call-control system where an IP address, a call state control function (CSCF) transport address, and registration to that CSCF are required before successful handover can be achieved. Preregistration toward the 3G system, including the provisioning of an IP address for the MT, an IP address for the CSCF, choice of a GGSN and an SGSN, and the pre-building of a PDP Context before the actual handover is used to minimize delays during the handover.

FIG. 1 illustrates an initial 3G deployment scenario in which there are pockets of 3G coverage 11 within a broader area of 2G coverage 12. It may be reasonably assumed that initial 3G deployment will be in "islands" of 3G coverage within an already installed 2G coverage area. As shown in FIG. 1, this implies that a dual-stack mobile terminal (MT) 13 may initially register and launch a voice call in a 2G coverage area. As the caller enters an area of 3G coverage, the decision to perform a handover must be made. In the present invention, this decision is based, not just on the availability of 3G coverage, but also on the service requirements of the user. For example, the need to check email, or to upgrade to a multimedia call may trigger a 2G-to-3G handover if the MT is in a 3G coverage area. Also illustrated is a Home Location Register/Home Subscriber Server (HLR/HSS) 14. The HLR/HSS verifies that the user has a 3G subscription, and chooses an Anchor GGSN and a properly located SGSN to service the MT after the handover.

FIG. 2 is an illustrative drawing of a 2G protocol stack and a 3G protocol stack in a dual-stack MT 13 suitable for use with the method of the present invention. The stacks may share a physical layer 16, or the physical layer may be separated. For example, the 3G stack may use Wideband Code Division Multiple Access (WCDMA) while the 2G stack uses GSM. At the link layer in the 2G circuit-switched stack, the Global System for Mobile Communications (GSM) protocol 17 is shown for illustrative purposes. At the application layer is a GSM coder/decoder (codec) 18. The 3G stack is slightly more complex and includes, above the physical layer, a Medium Access Control (MAC) protocol 19 and, at the link layer, a Radio Link Control (RLC) protocol 21 and a Packet Data Control Protocol (PDCP) 22. 3G services flow between the RLC and the PDCP layers. At the application layer is the

Internet Protocol (IP) 23. The MAC layer interacts with a service trigger layer 24.

The present invention introduces service triggers 24 to determine when 2G-to-3G handover is required. If a call starts in the 2G system where there is no 3G coverage, a decision to handover to a 3G system is based not just on the availability of 3G coverage, but also on the type of services required by the user, such as multimedia or WAP service. For example, a subscriber is running a real-time application on a laptop, and connects the laptop to the MS. The service trigger determines the service requirement and launches an appropriate call, in this case a 3G session (i.e., the service requirement drives the need for a 2G call or a 3G session). Because of the complexity of the 2G-to-3G handover, the system only goes to 3G if the service requirements demand it.

In an exemplary scenario, a subscriber is traveling, for example, on a train. The subscriber turns on his MT and attempts to start a multimedia session that requires multiple bearers in a 3G network. The MT scans for 3G coverage, but there is none available, so the MT manages only to seize the voice bearer in the 2G network. Therefore, the subscriber makes a 2G voice call. At a later time, the subscriber enters an area of 3G coverage, and the MT detects a 3G signal above a minimum attenuation level. Handover is performed for the voice call, and the 3G service trigger launches preregistration toward the 3G system for the multimedia session. Doppler analysis may be performed to verify that the subscriber is traveling toward the 3G system rather than tangentially or away from the 3G system. Preregistration is performed prior to requesting a 2G-to-3G handover in order to minimize the time required for the handover. Additionally, this process is consistent with the 3G.IP philosophy of maintaining separation of the user plane (media) and the control plane (control signaling). When the handover is complete, the multimedia application can seize another bearer for the video, providing the subscriber with the desired multimedia session.

In basic Voice-over-IP (VoIP) protocols such as H.323 or SIP, the MT must have an IP address and have a full IP stack running. In addition, the MT must have a Gatekeeper with a CSCF. Therefore, since the exemplary scenario involves handover to a 3G system, the HLR selects an SGSN or GGSN ahead of time for the call. It

should be noted that the same basic procedures may be applied to a Code Division Multiple Access (CDMA) packet-based system in which a Packet Data Service Node (PDSN) is implemented instead of an SGSN or a GGSN.

The present invention also introduces a Handover Server (HOSV). The HOSV may be implemented as a stand-alone node or in a node hierarchically at the same level as an MSC or SGSN, and which includes Handover Server Functionality. During preregistration, the HOSV is provided with the MT's International Mobile Subscriber Identity (IMSI) and its IP address, etc. and makes sure that the 3G session is ready to launch by creating PDP contexts and performing CSCF registration for the MT. In addition, the HOSV is needed for backward compatibility purposes with 2G nodes such as the Anchor Mobile Switching Center (MSC). In the standard 2G handover, there is an Anchor MSC where the call is initially served. The Anchor MSC exchanges information with later-serving MSCs in a Prepare Handover message, and expects to receive Prepare Handover responses. The HOSV receives the Prepare Handover message and ensures that the expected responses are sent to the Anchor MSC.

There is another problem regarding the Point-to-Point Protocol (PPP) linkage between the Terminal Equipment (TE) such as a laptop computer, and the MT that, together, comprise a 3G MT. In all 3G systems, communication flowing between the application in the laptop TE and the MT occurs over the PPP protocol. Creating the link requires a Link Control Protocol (LCP) and a Network Control Protocol (NCP) in which the layer 3 protocol is identified (for example, IP). It is during the NCP stage that the IP address and, optionally, the CSCF can be exchanged between TE and the MT.

FIGS. 3A-3C are a message flow diagram illustrating the messages, message content, and functions performed by network elements during a 2G-to-3G handover in accordance with the teachings of the present invention. Participating nodes in the network include the terminal equipment (TE) 31, the MT 13, a serving Universal Transmission Radio Access Network (UTRAN) 32, an SGSN 33, a GGSN 34, an HOSV 35, a CSCF 36, a Media Gateway Control Function (MGCF) 37, the HLR 14, a Media Gateway (MGW) 38, an MSC 39, and a Base Station Controller (BSC) 40.

Based on the service trigger 24 in the MT, it is determined that the MT initially requires only 2G service, and therefore a 2G GSM IMSI Attach message 41 is sent to the MSC 39. At 42, the message is passed to the HLR, and a 2G call is set up. During the 2G call at 43, the MT periodically scans for an indication of available 3G coverage. When 3G coverage is detected, the MT sends a 2G Direct Transfer Application Part (DTAP) message 44 to the MSC and includes the MT's IMSI and the Cell ID of the target 3G cell. The DTAP protocol is used to transfer call control, supplementary services management, and mobility management messages. The MSC sends a new 2G Mobile Application Part (MAP) message called the "3G Handover" (3G HO) message 45 to the HLR based on the IMSI of the MT. The 3G HLR (HLR/HSS) is modified to understand this message which is passed from the 2G MSC to the 3G HLR. At 46, the HLR checks the MT's subscriber profile to verify that the subscriber has a 3G subscription. If so, the HLR chooses an Anchor GGSN at 47 based on the Access Point Name (APN) and the IMSI. The APN indicates the subscriber's home ISP and home Public Land Mobile Network (PLMN), and thus the GGSN 34 can be identified. The SGSN is chosen through a location analysis based on the target 3G cell where the MT is receiving the strongest 3G signal. If the true SGSN/Routing Area turns out to be different, RNS relocation type of signaling may be utilized.

At 48, the HLR requests the provisioning of a IP address for the MS by sending a Build 3G PDP Context message to the GGSN 34. The Build 3G PDP Context message includes the MS's IMSI and MSISDN, the chosen SGSN, a target Routing Area, and an IP address request. At 49, the GGSN provides a dynamic IP address for the MT. The GGSN contains a Network Access Server (NAS) which provides dynamic IP addresses using the methodology in GSM 09.61 General Packet Radio Service (GPRS) or UMTS 29.061. The GGSN may provide the address itself or obtain an address from a Radius server.

In order to minimize the handover time, the GGSN provides the dynamic IP address to the CSCF in a proxy 3G CSCF registration process 51. During this process, the Anchor GGSN and the CSCF are provided with information elements that include the MT's IMSI, IP address and MSISDN. A Handover flag is also sent to the CSCF. Additionally, the information elements should include fast start parameters such as an

level, a measurement report 58 sent to the BSC causes the BSC to send a Handoff Required message 59 to the MSC indicating that handoff is required, and including a target cell for handoff. The service trigger 24 in the MT can force a handoff to a 3G cell. The MSC becomes an Anchor MSC, but instead of passing the MT to another MSC, it passes the MT to the HOSV 35. Thus, the MSC sends the target cell to the HOSV in a Prepare Handover Request message 61. At 62, the HOSV generates a handover number. Based on the handover number, the HOSV sends a Relocation Request 63 to the SGSN which was chosen previously for the MT's IMSI. The Relocation Request includes information elements for MM and PDP Contexts. This prepares the SGSN for handover.

At 64, the SGSN relays the Relocation Request to the serving UTRAN 32. The UTRAN sets up bearer channels on the radio side at 65 using the Access Link Control Application Part (ALCAP) protocol. ALCAP is a transport signaling protocol used in UMTS to set up and tear down transport bearers on the Iu, Iur, and Iub interfaces. The UTRAN then sends back a Relocation Request Acknowledgment message 66 to the SGSN. The SGSN, in turn, forwards the Relocation Request Acknowledgment to the HOSV at 67. The HOSV sends a new 3G call control message such as a Facility (or Setup) message 68 (H.225 or SIP) to the CSCF in the Gatekeeper indicating that handover is in progress. This message provides the CSCF with the handover number and the IP address of the MT which has already been received by the MT. Thus, the Gatekeeper is informed by the HOSV that it is getting a call from the MT.

This information must also be sent to the MGCF. In H.323, the gateway has been broken into two parts: the MGCF 37 and the MGW 38. There can be several MGWs controlled by one MGCF for scalability. The MGCF can also pick which MGW it wants. For the handover, the Gatekeeper CSCF sends a Facility message 69 to the MGCF indicating that there is a handover in progress. Facility Acknowledgment messages 71 and 72 are then returned to the CSCF and the HOSV. The HOSV then sends a Prepare Handover Response message 73 to the MSC with a handover number. The HOSV also indicates that the ISUP messaging should go to the MGCF.

The MSC then sends an ISUP Initial Address Message (IAM) 74 to the MGCF

Initial Logical Channel based on the original service triggers. The GGSN then informs the HLR in a Build 3G PDP Context Acknowledgment message 52 of the chosen gatekeeper (CSCF#) and the assigned IP address. A PLMN may have multiple CSCFs, and the choice of the CSCF by the GGSN may be by one of several different methodologies such as weighted average or load sharing.

The GGSN then sends an Update PDP Context message 53 to the SGSN 33 to inform the SGSN of the MT's IP address. A PDP Context must be established for any packet data flow, therefore a PDP Context record must be established in both the SGSN and the GGSN. The message also includes an initial Network-level Service Access Point Interface (NSAPI-1). The NSAPI is a GPRS-specific service access point (for services provided by the SNDCP layer 22) on top of which the IP stack resides. All IP datagrams flow down the protocol layers through the NSAPI. While the MT is involved in a strictly 2G call, there is no packet data stack with an IP address and an associated NSAPI. Therefore, for a 2G-to-3G handover, the NSAPI must be provided to the MT by the network along with an IP address and a Gatekeeper address to create a firm binding between a dynamically generated 3G terminal and the mobile. The NSAPI-1 is used along with the MT's IMSI to build a unique 3G Tunnel ID (TID) for the MT. As part of the message exchange, the SGSN creates an initial Mobility Management (MM) Context.

At 54, the GGSN sends an Update HOSV message to the HOSV 35, and includes the IMSI, Anchor GGSN, SGSN, and CSCF IP address. Architecturally and hierarchically, the HOSV is on the same level as an MSC.

At this point, a 2G MAP 3G HO Acknowledgment message 55 is sent from the HLR to the MSC, and includes the assigned IP address, NSAPI-1, and the CSCF IP address as an optional information element. The MSC then sends a 2G DTAP Acknowledgment message 56 to the MT and includes the assigned IP address, NSAPI-1, and the CSCF along with 3G service-dependent parameters such as the RTP Logical Channels (LCN). A PPP LCP/NCP link 57 is then established between the MT and the TE, and the above parameters and information elements are used for launching a TCP/IP-based 3G stack. The process then moves to FIG. 3B.

When the MT's signal strength with the serving cell drops below a threshold

and includes the handover number, Carrier Identification Code (CIC) number, and the Destination Point Code (DPC) of the MGCF. At 75, the MGCF matches the handover number with the handover number received in the Facility message 69 to determine which CSCF sent it. The MGCF then establishes a virtual connection for a 3G RTP termination with the 2G circuit-switched CIC by sending a Megaco CTX=ADD message 76 to the MGW. The MGW returns a CTX Response OK message 77, and the process then moves to FIG. 3C.

The MGCF then sends a Facility Redirect message 78 to the CSCF, and the message is forwarded to the HOSV at 79. This message informs the CSCF and the HOSV that the Megaco termination for this particular call has been set up. The HOSV then sends a Call Proceeding message 81 to the CSCF, and the message is forwarded to the MGCF at 82. These messages must go through the CSCF because the HOSV is acting as a proxy for the MT. An ACM message 83 is then sent from the MGCF to the MSC, and the MSC sends a Handover Command 84 to the BSC. The BSC then sends a Relocation Command 85 to the MT. The call is then switched to the 3G system at 86.

A Relocation Detect message 87is sent from the MT to the HOSV via the serving UTRAN and the SGSN. Alerting is performed as normal, and the HOSV sends an Alerting signal 88 to the MGCF via the CSCF. Call Proceeding (CPG) is sent as normal from the MGCF to the MSC at 89. A Relocation Complete message 91 is then sent from the MT to the HOSV via the serving UTRAN and the SGSN. At 92, the HOSV sends a MAP Send End Signal Request as normal to the MSC. At 93, a Clear command is sent between the MSC and the BSC. At 94, the MT notifies the TE that full 3G coverage is provided, and the protocol stack is switched to the 3G stack at 95. A Facility Call Reconnect message 96 is then sent from the MT directly to the CSCF to demonstrate that the MT can talk to the CSCF directly. The CSCF then sends a Modify Call Context (CTX) message 97 to the MGCF, and the MGCF forwards the message to the MGW. At 98, the MGW returns a CTX Response OK message to the MGCF. Finally, an Answer Message (ANM) 99 is sent from the MGCF to the MSC indicating that the call is in progress, and diverting the 2G speech circuit towards the MSC.

Although the setting up of the 2G-to-3G handover is complex, the extra revenue earned by operators from these value-added services supports the implementation of 2G-to-3G handovers.

It is thus believed that the operation and construction of the present invention will be apparent from the foregoing description. While the method shown and described has been characterized as being preferred, it will be readily apparent that various changes and modifications could be made therein without departing from the scope of the invention as defined in the following claims.

WHAT IS CLAIMED IS:

1. In a method of handing over a mobile terminal from a first cell to a second cell of the type in which the first cell is in a first type of network, and the second cell is in a second type of network, the improvement wherein the handover is triggered by a request for a service that requires a capability of the second type of network.

2. The method of handing over a mobile terminal of claim 1 wherein the first type of network is a second generation (2G) circuit-switched radio telecommunications network, and the second type of network is a third generation (3G) Internet Protocol (IP)-based radio telecommunications network.

3. A method of handing over a mobile terminal from a second generation (2G) circuit-switched radio telecommunications network to a third generation (3G) Internet Protocol (IP)-based radio telecom-munications network, said method comprising the steps of:

establishing a call from the mobile terminal in the 2G network;

determining that the mobile terminal is operating in an area of 3G network coverage;

determining that the mobile terminal is requesting a service that requires 3G network coverage; and

handing over the mobile terminal from the 2G network to the 3G network.

4. The method of handing over a mobile terminal of claim 3 further comprising, after the step of determining that the mobile terminal is operating in an area of 3G network coverage, the step of preregistering the mobile terminal with the 3G network.

5. The method of handing over a mobile terminal of claim 4 wherein the step of preregistering the mobile terminal with the 3G network includes the steps of:

acquiring an IP address for the mobile terminal;

acquiring a Gatekeeper having a Call State Control Function (CSCF); and

preregistering the mobile terminal with the CSCF.

6. The method of handing over a mobile terminal of claim 5 wherein the step of preregistering the mobile terminal with the 3G network also includes the steps of:

selecting a Gateway General Packet Radio Service (GPRS) Service Node (GGSN) as an Anchor GGSN; and

selecting a Serving GPRS Service Node (SGSN) serving a target cell in the 3G network.

7. The method of handing over a mobile terminal of claim 6 wherein the step of selecting an Anchor GGSN includes selecting an Anchor GGSN based on an Access Point Name (APN) and an International Mobile Subscriber Identity (IMSI) for the mobile terminal.

8. The method of handing over a mobile terminal of claim 6 wherein the step of selecting an SGSN includes selecting the SGSN through a location analysis based on the target cell in the 3G network from which the mobile terminal is receiving a strongest signal.

9. The method of handing over a mobile terminal of claim 4 wherein the step of preregistering the mobile terminal with the 3G network includes providing a Handover Server (HOSV) with the mobile terminal's International Mobile Subscriber Identity (IMSI) and its IP address.

10. The method of handing over a mobile terminal of claim 9 further comprising implementing the HOSV at the same hierarchical level as a Mobile Switching Center (MSC).

11. The method of handing over a mobile terminal of claim 10 wherein the step of handing over the mobile terminal from the 2G network to the 3G network includes the steps of:

sending from the MSC to the HOSV, an identity of a target cell in the 3G network from which the mobile terminal is receiving a strongest signal, said target cell identity being sent in a Prepare Handover Request message; and

sending Prepare Handover Responses from the HOSV to the MSC.

12. The method of handing over a mobile terminal of claim 11 wherein the step of handing over the mobile terminal from the 2G network to the 3G network includes the steps of:

selecting a Serving GPRS Service Node (SGSN) serving the target cell, by performing a location analysis based on the target cell in the 3G network from which the mobile terminal is receiving a strongest signal; and

preparing the SGSN for handover by sending a Relocation Request from the HOSV to the SGSN, said Relocation Request including information elements for Mobility Management (MM) and Packet Data Protocol (PDP) Contexts.

13. The method of handing over a mobile terminal of claim 4 further comprising modifying a Home Location Register (HLR) in the 3G network to receive a "3G Handover" (3G HO) message, said message being a 2G Mobile Application Part (MAP) message which includes the International Mobile Subscriber Identity (IMSI) for the mobile terminal and a target cell in the 3G network from which the mobile terminal is receiving a strongest signal.

14. The method of handing over a mobile terminal of claim 13 wherein the step of preregistering the mobile terminal with the 3G network includes verifying by the HLR that the mobile terminal has a 3G subscription upon receiving the 3G HO message in the HLR.

15. The method of handing over a mobile terminal of claim 14 wherein the

step of preregistering the mobile terminal with the 3G network includes, upon verifying by the HLR that the mobile terminal has a 3G subscription, the steps of:

selecting by the HLR, a Gateway General Packet Radio Service (GPRS) Service Node (GGSN) as an Anchor GGSN; and

selecting by the HLR, a Serving GPRS Service Node (SGSN) serving the target cell in the 3G network from which the mobile terminal is receiving a strongest signal.

16. A method of handing over a mobile terminal from a second generation (2G) Anchor Mobile Switching Center (MSC) in a 2G circuit-switched radio telecommunications network to a Serving General Packet Radio Service (GPRS) Service Node (SGSN) in a third generation (3G) Internet Protocol (IP)-based radio telecommunications network, said method comprising the steps of:

detecting by the mobile terminal that coverage is available from a target cell in the 3G network;

preregistering the mobile terminal with the 3G network;

determining whether the mobile terminal is requesting a service that requires 3G network coverage;

retaining the mobile terminal in the 2G network if the mobile terminal is not requesting a service that requires 3G network coverage; and

handing over the mobile terminal from the 2G network to the 3G network if the mobile terminal is requesting a service that requires 3G network coverage.

17. The method of handing over a mobile terminal of claim 16 wherein the step of preregistering the mobile terminal with the 3G network includes the steps of:

acquiring an IP address for the mobile terminal;

acquiring a Gatekeeper having a Call State Control Function (CSCF);

preregistering the mobile terminal with the CSCF;

selecting a Gateway GPRS Service Node (GGSN) as an Anchor GGSN; and

selecting the SGSN serving the target cell in the 3G network.

18. The method of handing over a mobile terminal of claim 17 wherein the step of preregistering the mobile terminal with the CSCF includes enhancing the CSCF to perform a preregistration and retain the registration until a request for a 3G service triggers a handover of the mobile terminal to the 3G network.

19. The method of handing over a mobile terminal of claim 16 wherein the step of handing over the mobile terminal from the 2G network to the 3G network includes implementing a Handover Server in the 3G network to interface with the 2G Anchor MSC and maintain backward compatibility by providing responses expected by the 2G Anchor MSC in a 2G handover.

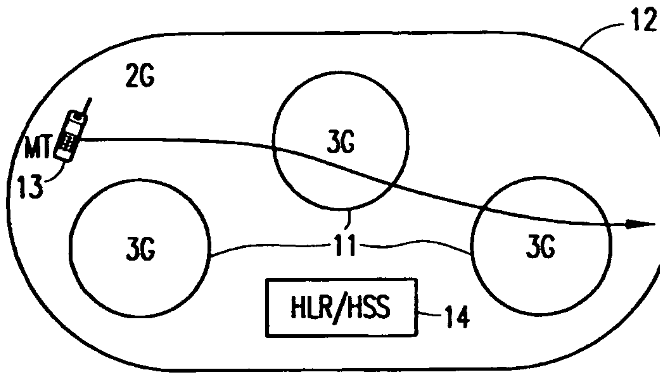

12
2G
MT
13
3G
3G
11
3G
HLR/HSS
14

FIG. 1

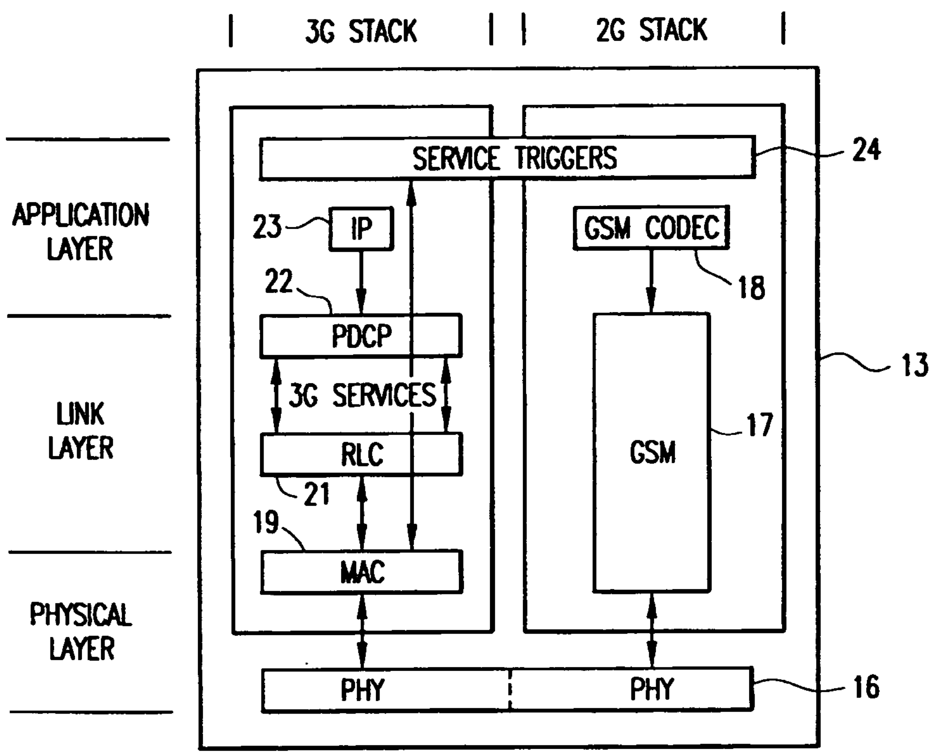
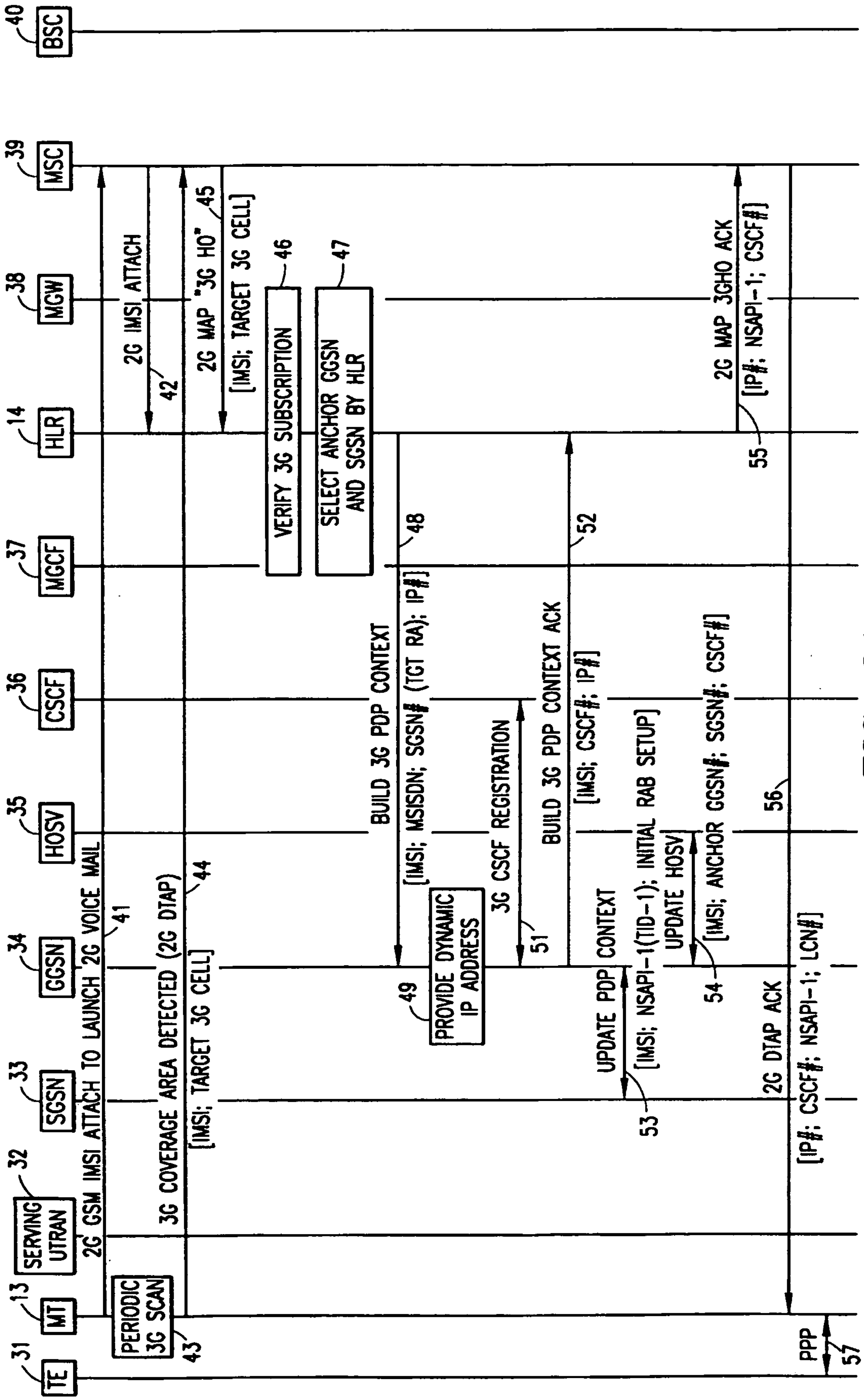

3G STACK
2G STACK
SERVICE TRIGGERS
24
APPLICATION LAYER
23
IP
GSM CODEC
22
18
PDCP
13
LINK LAYER
3G SERVICES
17
GSM
RLC
21
19
MAC
PHYSICAL LAYER
PHY
PHY
16

FIG. 2



TE 31
MT 13
SERVING UTRAN 32
SGSN 33
GGSN 34
HOSV 35
CSCF 36
MGCF 37
HLR 14
MGW 38
MSC 39
BSC 40
PERIODIC 3G SCAN 43
2G GSM IMSI ATTACH TO LAUNCH 2G VOICE MAIL 41
2G IMSI ATTACH 42
3G COVERAGE AREA DETECTED (2G DTAP) 44
[IMSI; TARGET 3G CELL]
2G MAP "3G HO" 45
[IMSI; TARGET 3G CELL]
VERIFY 3G SUBSCRIPTION 46
SELECT ANCHOR GGSN AND SGSN BY HLR 47
BUILD 3G PDP CONTEXT 48
[IMSI; MSISDN; SGSN# (TGT RA); IP#]
PROVIDE DYNAMIC IP ADDRESS 49
3G CSCF REGISTRATION 51
BUILD 3G PDP CONTEXT ACK 52
[IMSI; CSCF#; IP#]
UPDATE PDP CONTEXT 53
[IMSI; NSAPI-1(TID-1); INITIAL RAB SETUP]
UPDATE HOSV 54
[IMSI; ANCHOR GGSN#; SGSN#; CSCF#]
2G MAP 3GHO ACK 55
[IP#; NSAPI-1; CSCF#]
2G DTAP ACK 56
[IP#; CSCF#; NSAPI-1; LCN#]
PPP 57

FIG. 3A

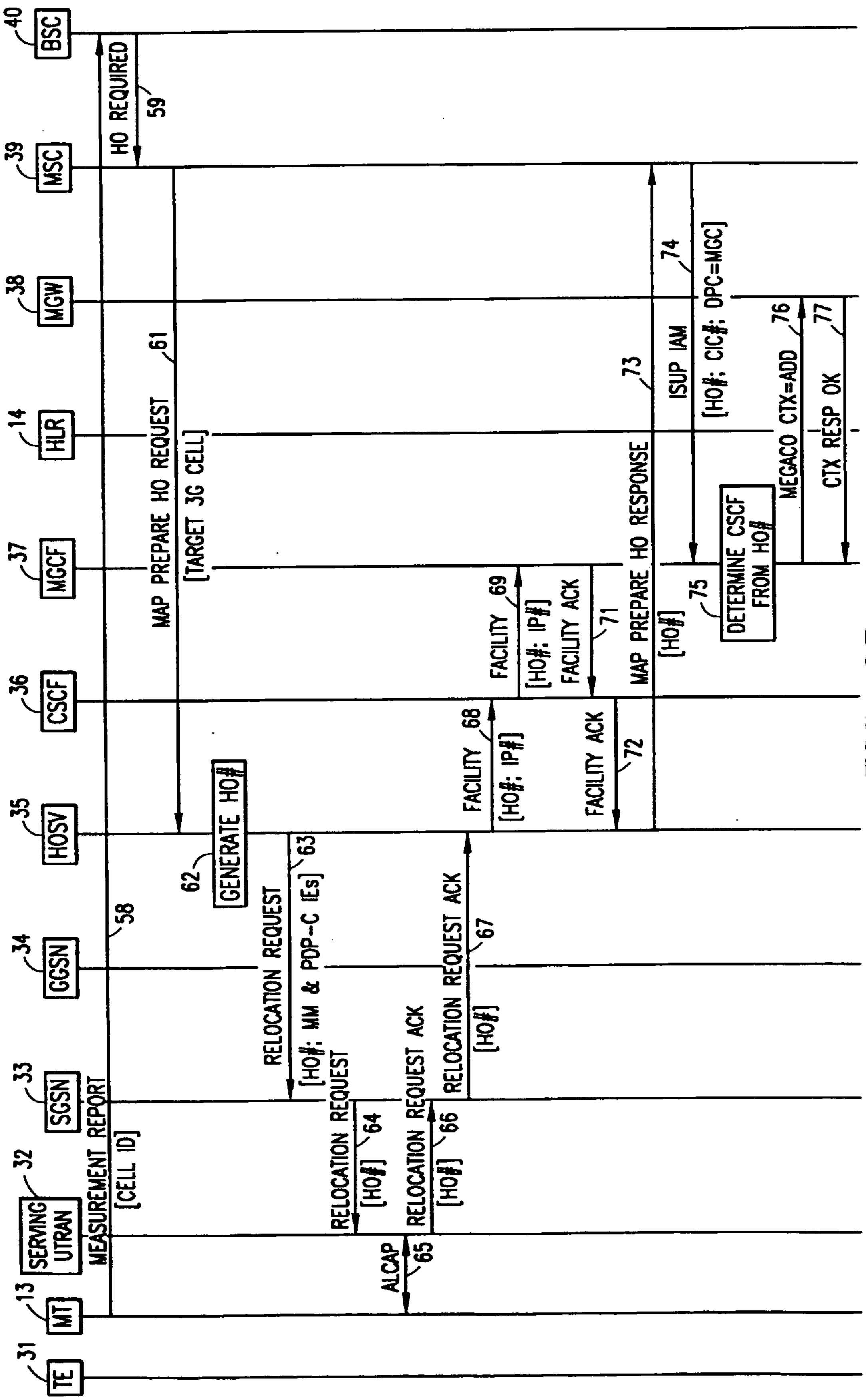

BSC
40
MSC
39
MGW
38
HLR
14
MGCF
37
CSCF
36
HOSV
35
GGSN
34
SGSN
33
SERVING UTRAN
32
MT
13
TE
31
MEASUREMENT REPORT
[CELL ID]
58
HO REQUIRED
59
MAP PREPARE HO REQUEST
[TARGET 3G CELL]
61
GENERATE HO#
62
RELOCATION REQUEST
[HO#; MM & PDP-C IEs]
63
RELOCATION REQUEST
[HO#]
64
ALCAP
65
RELOCATION REQUEST ACK
[HO#]
66
RELOCATION REQUEST ACK
[HO#]
67
FACILITY
[HO#; IP#]
68
FACILITY
[HO#; IP#]
69
FACILITY ACK
71
FACILITY ACK
72
MAP PREPARE HO RESPONSE
[HO#]
73
ISUP IAM
[HO#; CIC#; DPC=MGC]
74
DETERMINE CSCF FROM HO#
75
MEGACO CTX=ADD
76
CTX RESP OK
77

FIG. 3B

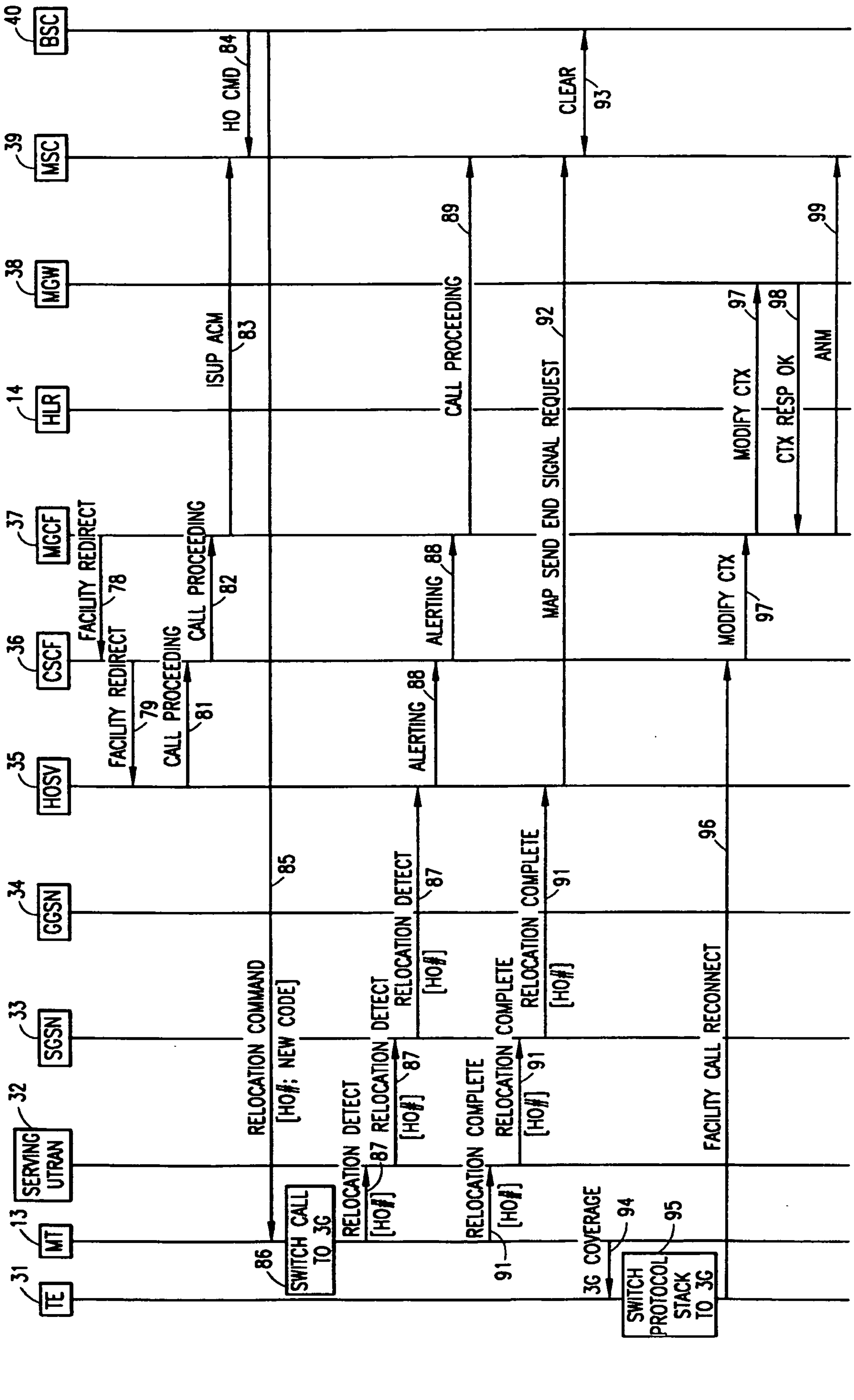

TE
31
MT
13
SERVING UTRAN
32
SGSN
33
GGSN
34
HOSV
35
CSCF
36
MGCF
37
HLR
14
MGW
38
MSC
39
BSC
40
FACILITY REDIRECT
78
FACILITY REDIRECT
79
CALL PROCEEDING
81
CALL PROCEEDING
82
ISUP ACM
83
HO CMD
84
RELOCATION COMMAND
[HO#; NEW CODE]
85
SWITCH CALL TO 3G
86
RELOCATION DETECT
[HO#]
87
RELOCATION DETECT
[HO#]
87
RELOCATION DETECT
[HO#]
87
ALERTING
88
ALERTING
88
CALL PROCEEDING
89
RELOCATION COMPLETE
[HO#]
91
RELOCATION COMPLETE
[HO#]
91
RELOCATION COMPLETE
[HO#]
91
MAP SEND END SIGNAL REQUEST
92
CLEAR
93
3G COVERAGE
94
SWITCH PROTOCOL STACK TO 3G
95
FACILITY CALL RECONNECT
96
MODIFY CTX
97
MODIFY CTX
97
CTX RESP OK
98
ANM
99

FIG. 3C